Impacts of climate change and melting glaciers on coastal ecosystems in the nearshore waters of the Gulf of Alaska.

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This project addresses the impact of climate change and melting glaciers on the fluxes of fresh water, and of the essential nutrients nitrate and iron, on the coastal ecosystem in the Copper River region of the Gulf of Alaska. The project includes both terrestrial and marine components. The terrestrial part of this study will focus on the Copper River and its tributaries to examine how melting of glaciers is altering the magnitude and timing of freshwater supply from the Copper River, as well as the impact of glacier melting on present and future supply of the nutrients iron and nitrate from the river and from estuarine upwelling. The rates of glacier recession will be assessed from remote sensing and physical observations of glaciers (E. Josberger, USGS-Tacoma). The rate of discharge from the Copper River, and its contributions from precipitation, snowmelt and glacier melting will be inferred (T. Brabets, USGS-Anchorage, with NGO support). A set of glaciated, deglaciated and periglacial tributaries of the Copper River will be sampled to examine present-day nutrient cycling in each of these settings, and to use a space-for-time substitution to make predictions about the future evolution of nutrients transported to the Gulf of Alaska from the Copper River. The flux and speciation of iron will be examined (Schroth and Crusius, USGS- Woods Hole), with the hypothesis that glaciated tributaries supply large amounts of reactive particulate iron that fuels a large dissolved Fe pool in offshore waters, while deglaciated tributaries maintain wetlands that yield much lower particulate iron loads, yet promote DOC-rich waters with high dissolved iron concentrations. By contrast, glaciated tributaries are predicted to maintain low nitrate concentrations (to be examined by Kroeger, USGS-Woods Hole); however, immediately following deglaciation, alders and other nitrogen-fixing plants are predicted to establish themselves, leading to a much larger riverine nitrate load than occurred prior to the retreat of the glacier. As glaciers continue to recede, this invasion by nitrogen fixing plants, and reduction in particulate iron load, has the potential to have a large impact on the present-day coastal, Fe-rich, N-poor ecosystem.

The marine component will build upon three research cruises per year to conduct transects from the Copper River mouth to beyond the shelf break. We will study the Copper River plume as a biological hotspot, examining both seasonal and interannnual change. The project will test the hypothesis that populations of fish, with critical life-stage requirements dependent on near-shore waters, are supported by phytoplankton and zooplankton populations, which are in turn controlled by nutrient inputs from glacier melt, riverine input, and the estuarine upwelling that results from freshwater inputs of these glacier-dominated rivers to the coast. Dissolved iron samples will be collected (Crusius and Schroth, USGS-Woods Hole) using an underway pumping system, while underway measurements of nitrate, chl-a, turbidity and zooplankton abundance will be carried out using an undulating towed body (R. Campbell, PWSSC). From a separate

vessel, fish will be enumerated with a surface trawl and their otoliths removed for later analysis (supervised by J. Nielsen, USGS-Anchorage). Data from these cruises will be interpreted with the aid of physical oceanographic modeling (ROMS: Y. Chao- JPL) and ecosystem modeling (NPZ: F. Chai-U. Maine).

The project will result in a variety of presentations and journal publications. The primary products that will be useful to resource managers will include the ecosystem model results that describe how the present-day coastal ecosystem responds to seasonal changes in snowmelt, glacier melt, precipitation, upwelling, nutrient supply as well as the predictions about future ecosystem change in response to glacial recession in the coming decades. The journal articles describing the present-day dependence of the Copper River ecosystem on these various processes will also be of interest to managers.